

# Emissions, Energy Returns, and Economics: Using Forest Residues for Thermal Energy Compared to Onsite Pile Burning

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# Is Using Forest Residues for Energy Production a Good Idea?

- Effect on Greenhouse Gas and Particulate Matter emissions?
- What is the energy return ratio?
  - Diesel fuel needed to collect, grind, and haul biomass for energy?
  - How affected by haul distance?
- Economically viable?

# Compared Two Forest Residue Disposal Options:

**1) Grind and haul residues to biomass boiler for heat energy**

**2) Burn residues onsite and use fossil fuel for equivalent heat energy**

-- Natural Gas

-- Distillate Oil



**Option 2**

Pile Burn at Landing



Use fossil fuels for energy



**Option 1**

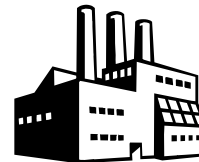
Grind



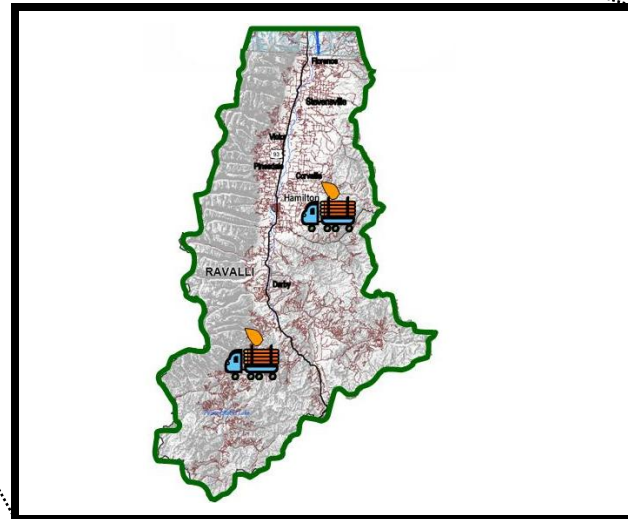
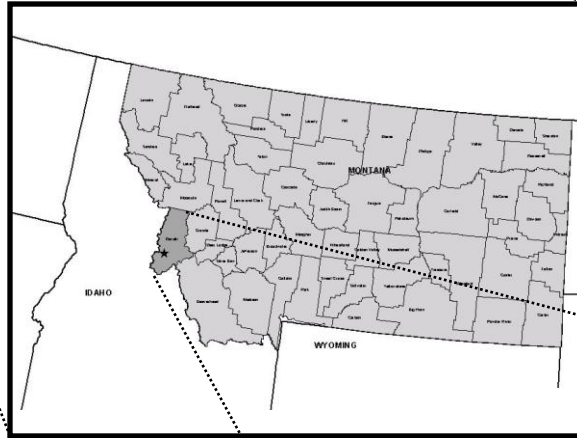
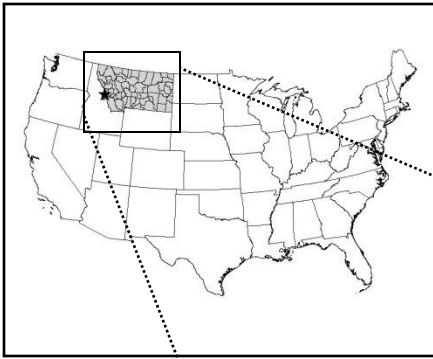
Haul



Burn wood for energy



# Bitterroot Study Area, Montana, USA

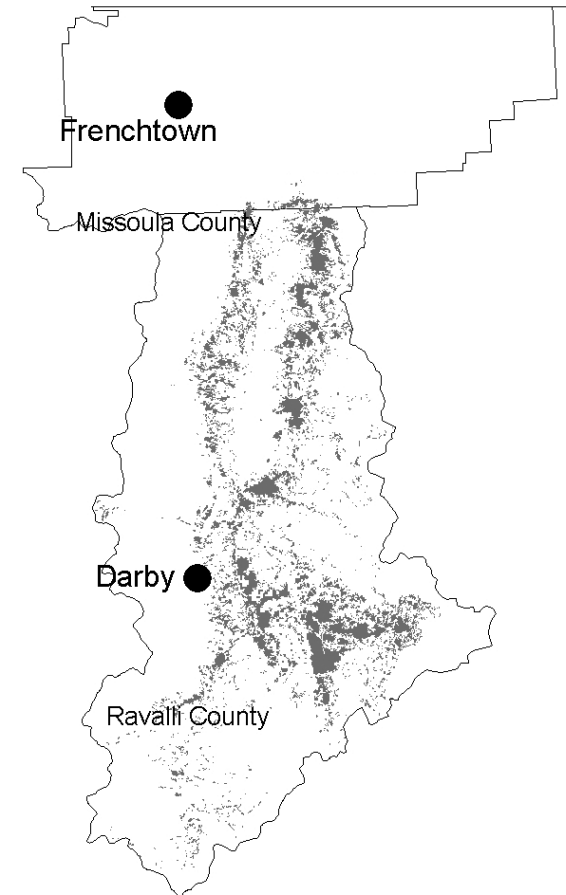


# Vegetation Treatment Modeling

- Comprehensive Restoration Thinning (Fielder, UM)
  - Fuel treatment
  - Forest restoration
- Whole Tree Harvesting
- FVS used to model treatments on FIA and other plot data (900+ plots analyzed)
  - Biomass residue volume (tops and limbs of commercial trees, and small trees)
- Plots related to R1 VMap (stand) polygons in GIS

# Treatment Unit Polygons

- R1 VMap Forest Vegetation Coverage (GIS)
  - Dominate Species
  - Size Class
  - Density
- Low elevation, frequent fire regime
- Fire regime condition class 2 and 3
- Non-reserved National Forest and private
- Slopes  $\leq 35\%$
- Distance to road  $\leq 1,500$  ft.

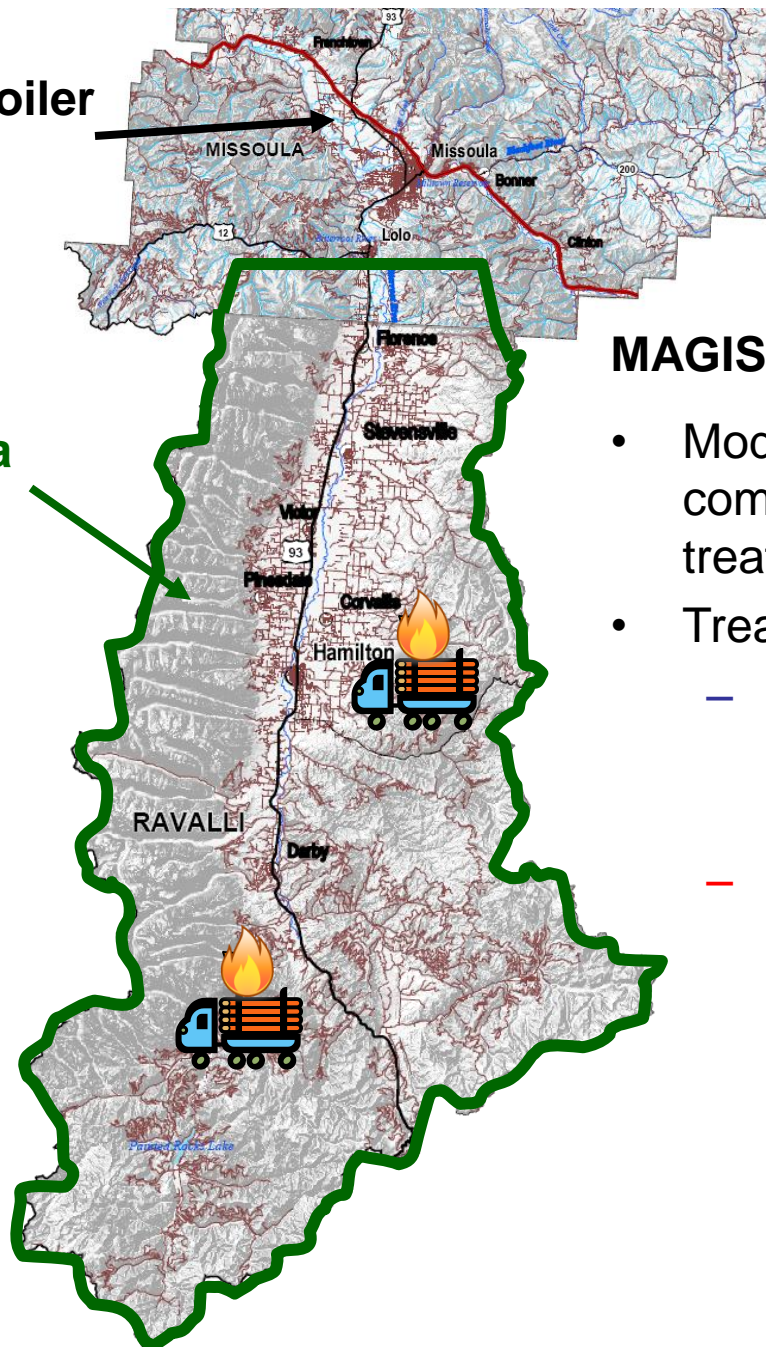


# Sources for Diesel Consumption, Fuel Heat Energy, and Emission Factors

- Diesel consumption
  - Logging: 2004 CORRIM Report
  - Grinding and hauling biomass: Forest Residues Trucking Simulator (So. Res. Sta.)
- Fuel heat energy: Fuel Value Calculator (Forest Products Lab.)
- Emission factors
  - Diesel engines and boiler: EPA Report AP-42
  - Pile burning: Hardy and others 2001 (International Journal of Wildland Fire)

**Biomass Boiler**

**Study Area**

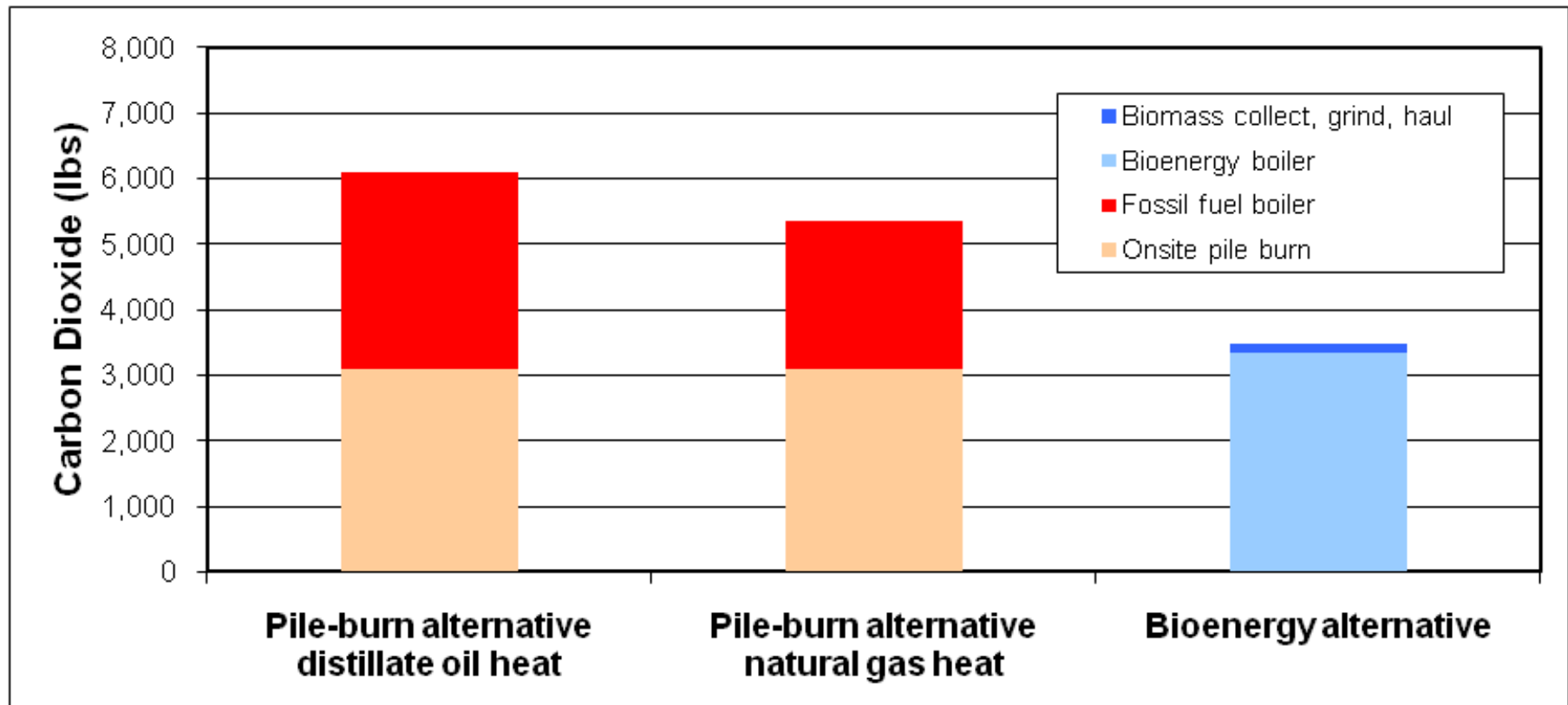


### **MAGIS used for Analysis:**

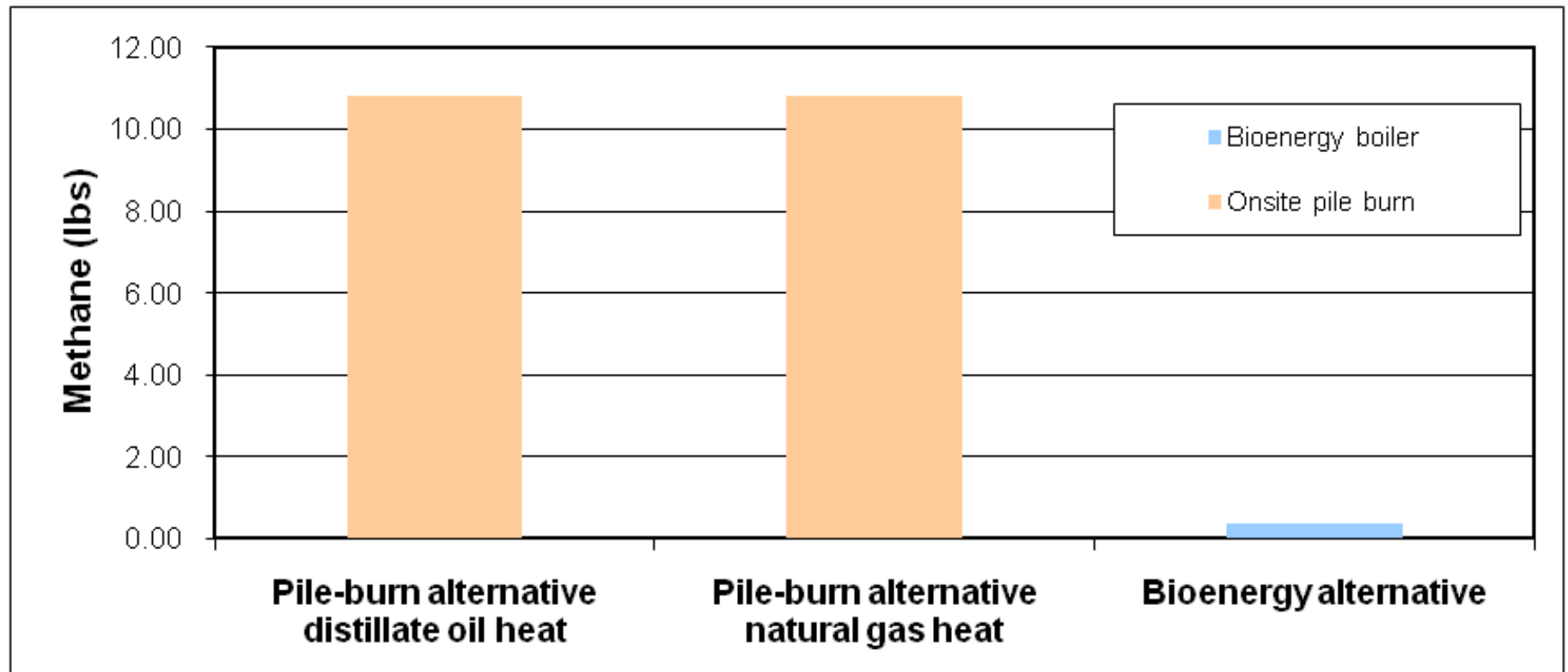
- Model applying the comprehensive restoration treatment on polygons
- Treatment residues either:
  - Loaded onto road network and hauled to Biomass Boiler (Option 1)
  - Burned on site (Option 2)



# Carbon Dioxide Emissions per Dry Ton Treated

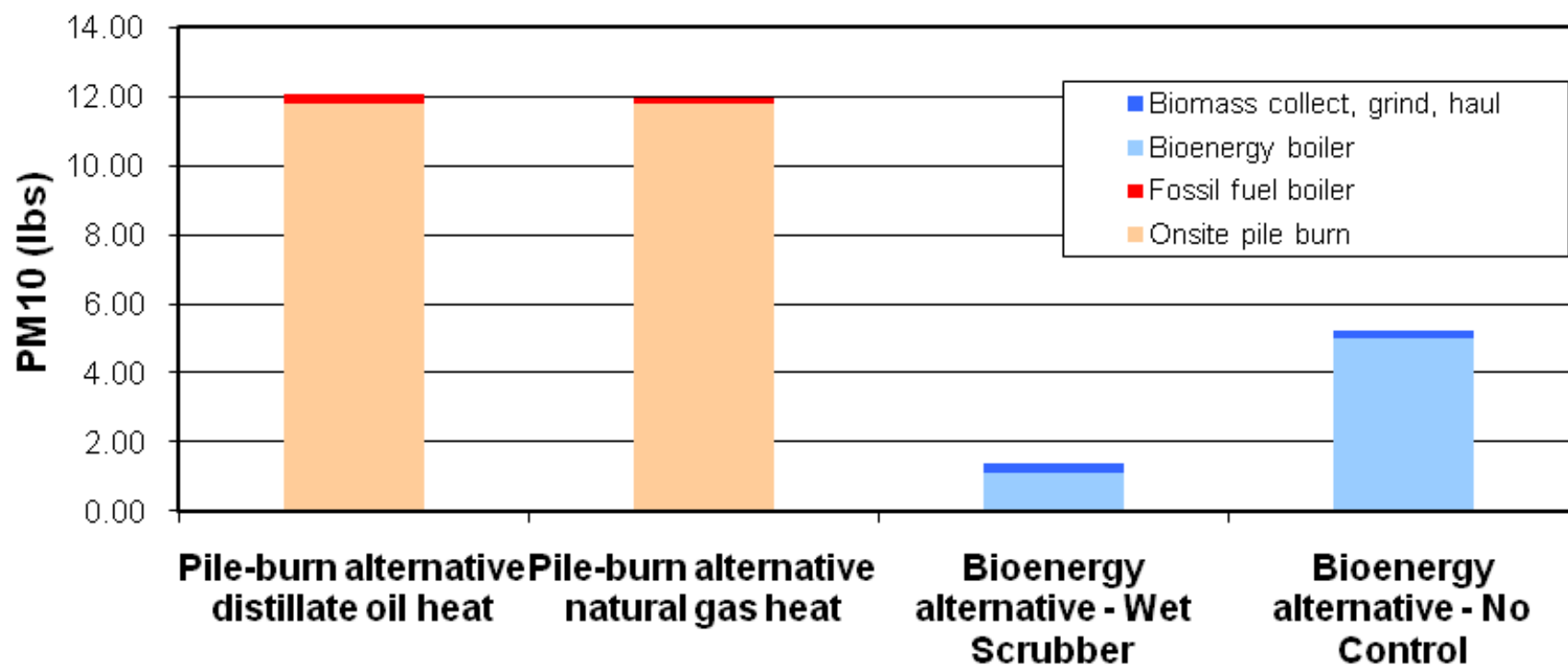


# Methane Emissions per Dry Ton Treated



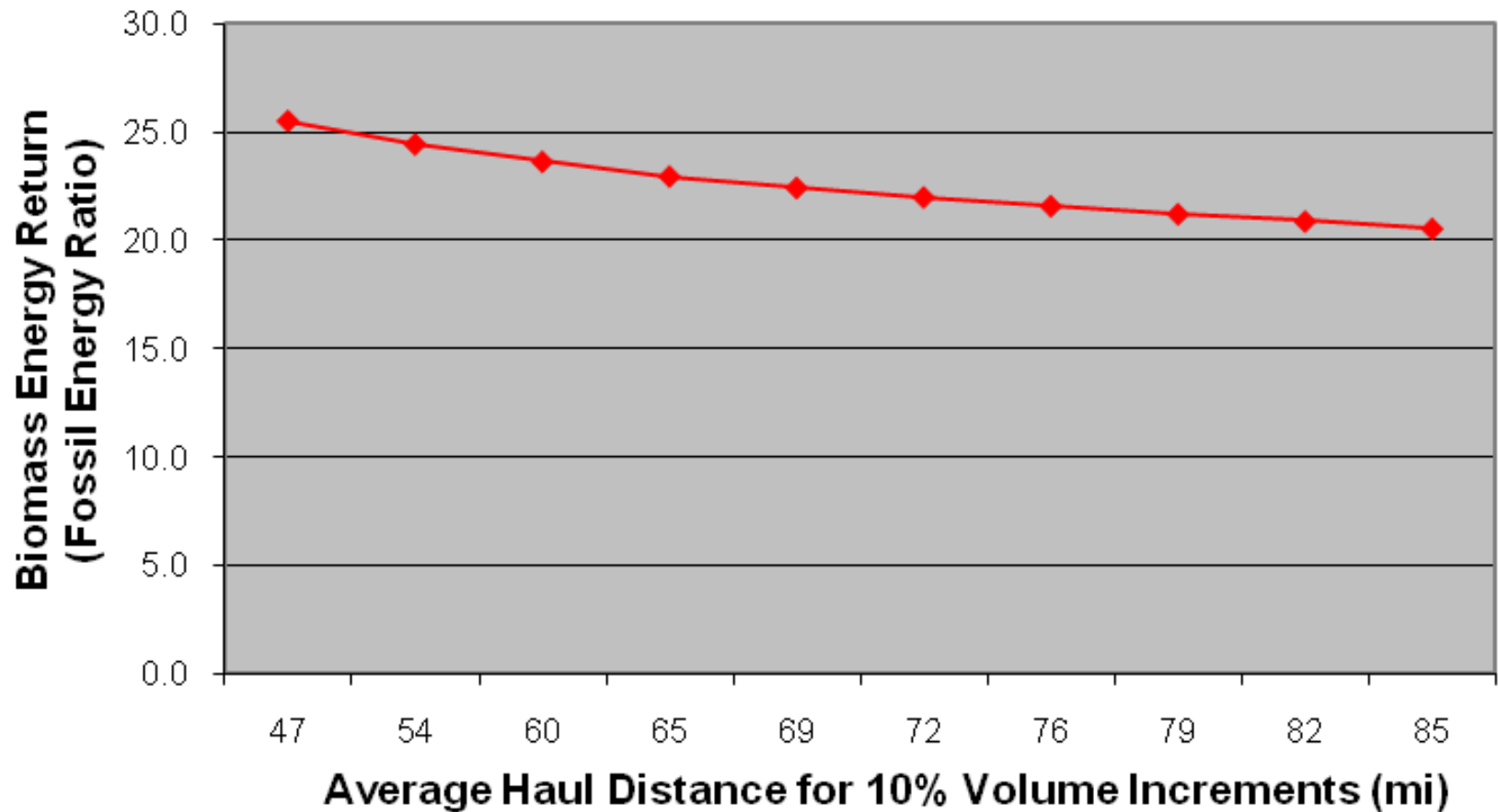
# PM10 Emissions per Dry Ton Treated

(Particulate Matter < 10 microns)

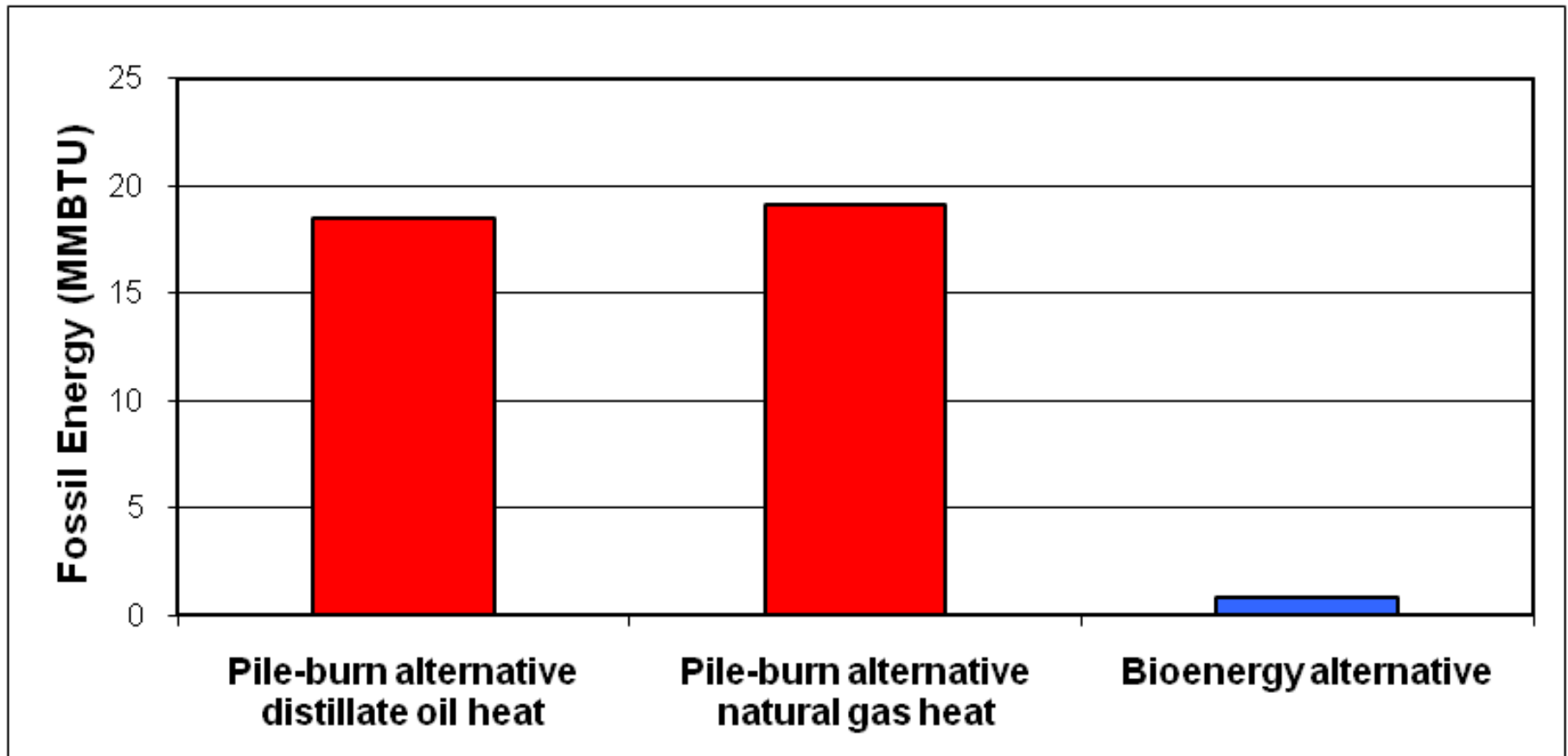


# Biomass Energy Return

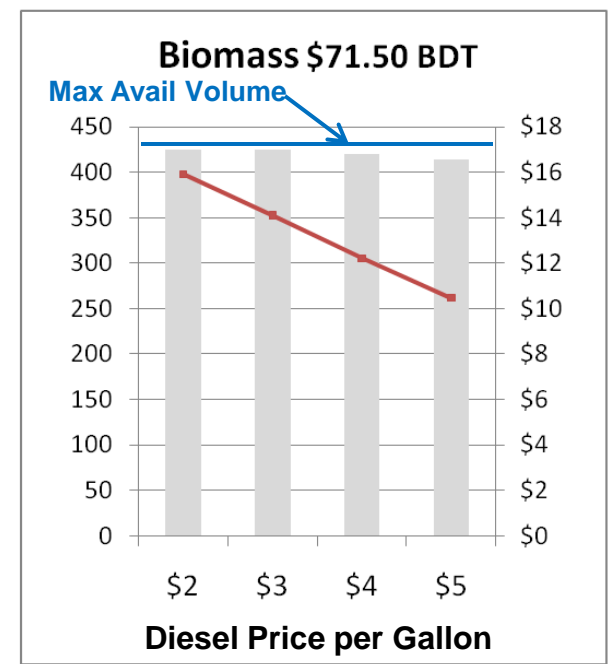
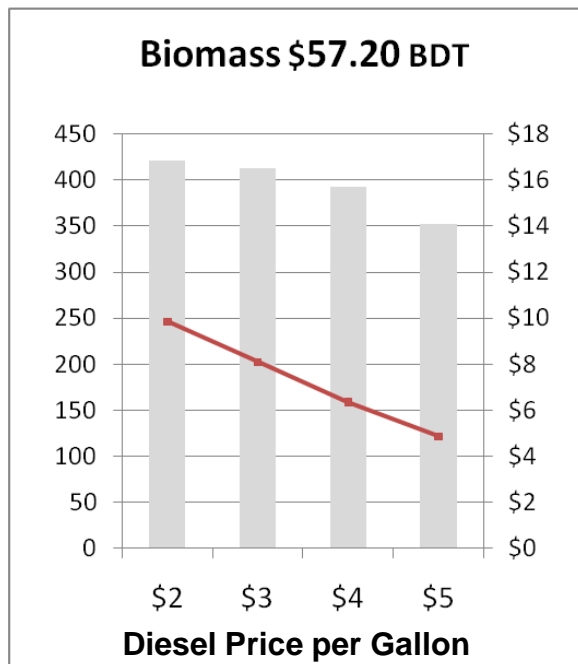
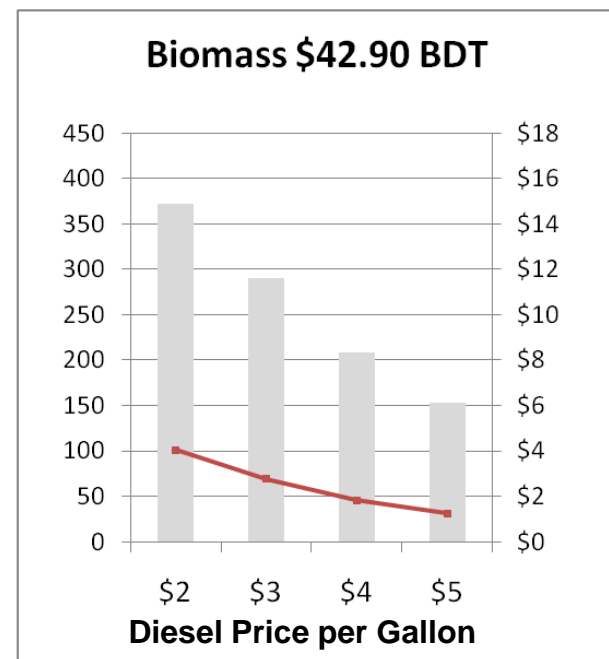
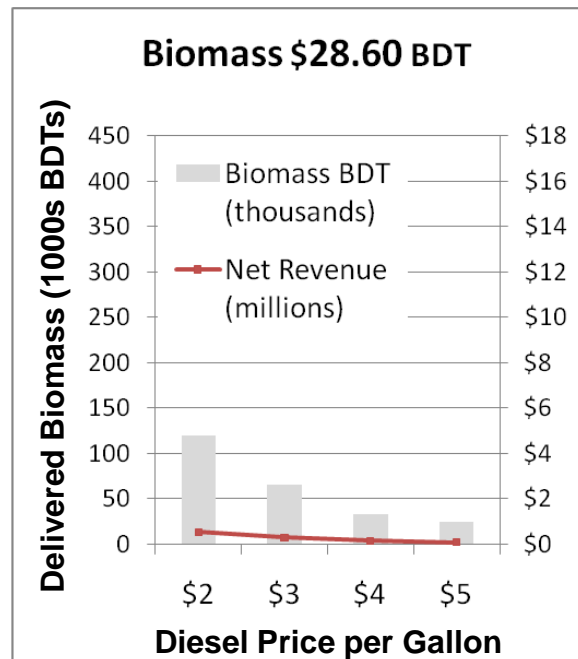
(Bioenergy Obtained / Diesel Energy Expended)

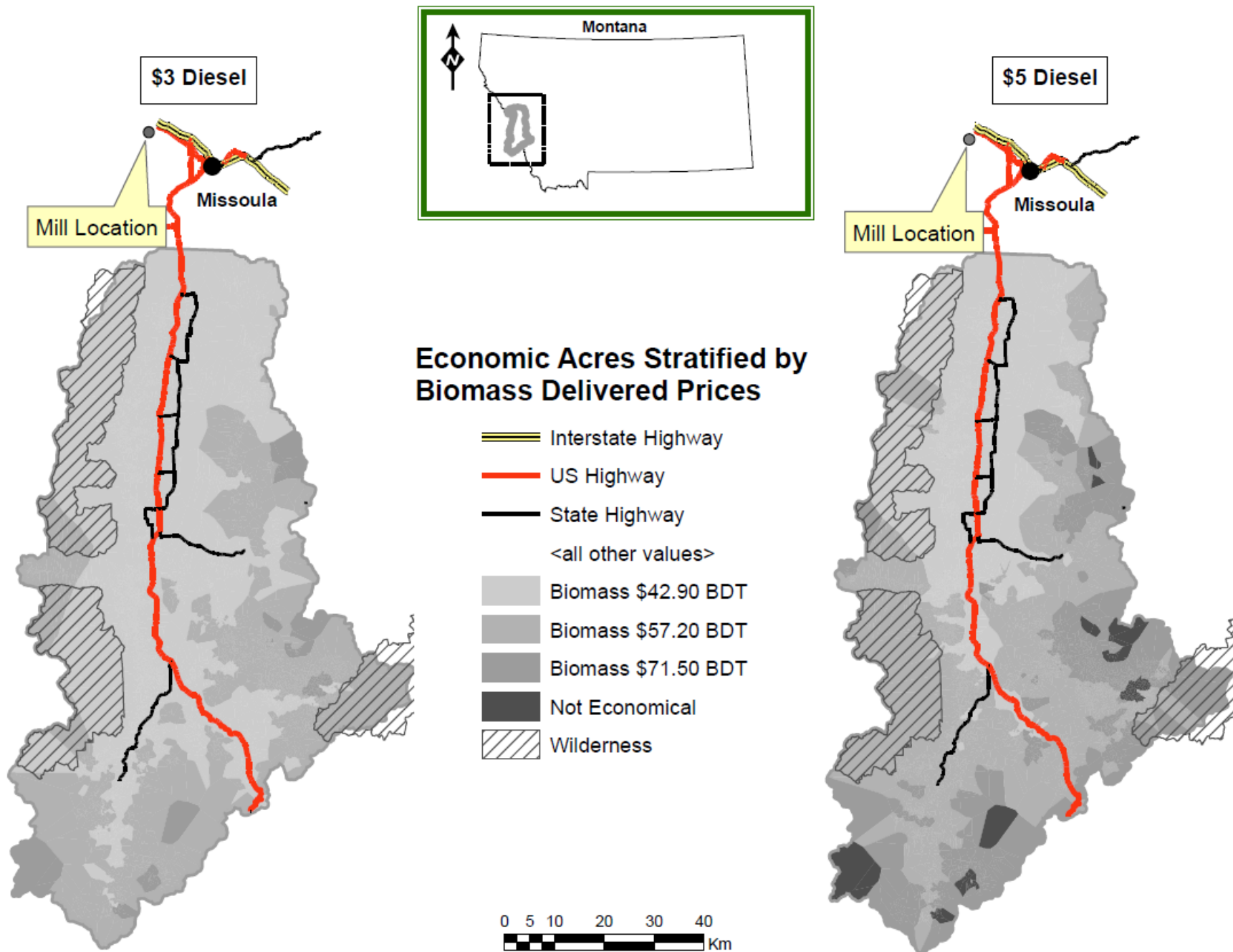


**Fossil fuel energy consumed to collect, grind, and haul one dry ton of biomass (bioenergy alternative) compared to fossil fuel energy consumed for the equivalent heat energy (pile burn alternatives)**



# Financially Feasible Biomass at Various Delivered Biomass Prices and Diesel Fuel Costs









# Questions?

## Published References:

Jones, Greg; Loeffler, Dan; Calkin, David; Chung, Woodam 2010. Forest treatment residues for thermal energy compared with disposal by onsite burning: Emissions and energy return. *Biomass and Bioenergy*. 34(5): 737-746.

Jones, Greg; Loeffler, Dan; Butler, Edward; Chung, Woodam; Hummel, Susan. 2009. Emissions, Energy Return and Economics from Utilizing Forest Residues for Thermal Energy Compared to Onsite Pile Burning. In: *Proceedings of the 2009 National Silviculture Workshop, USDA Forest Service Proceedings RMRS-P-61*, p. 145-158.